

CLAIMS

1. (Currently Amended) A method of video contrast enhancement comprising:
 setting a first pixel level threshold for an input video frame in a video sequence,
 the input video frame including a plurality of pixels having corresponding pixel values within a pixel value range, where the first pixel level threshold is set to one of the pixel values within the pixel value range;
 when a given input-video-frame pixel's level value is below the pixel level threshold, remapping that pixel according to an adaptive contrast-enhancing function; and
 when the given input-video-frame pixel's level value is above the pixel level threshold, remapping that pixel according to a scene-stable mapping function.
2. (Canceled)
3. (Currently Amended) The method of claim 1, further comprising:
 setting a second pixel level threshold for an input video frame, the second threshold higher than the first; and
 when a given input-video-frame pixel's level value is above the second pixel level threshold, remapping that pixel to a new level according to a second adaptive contrast-enhancing function.
4. (Original) The method of claim 1, wherein setting a first pixel level threshold comprises setting a threshold that places a selected percentage of the input video frame's pixels below the threshold.
5. (Original) The method of claim 4, wherein the threshold is estimated from pixel values obtained from one or more previous input video frames.
6. (Original) The method of claim 1, wherein setting a first pixel level threshold comprises setting the threshold to a fixed level for at least the duration of a scene.
7. (Original) The method of claim 1, further comprising calculating the adaptive contrast-enhancing function to remap an input histogram for pixels below the pixel level threshold to a new histogram specification.

8. (Original) The method of claim 7, wherein the new histogram specification is a uniform distribution.

9. (Original) The method of claim 7, further comprising tabulating the input histogram from the pixels of the input video frame.

10. (Original) The method of claim 7, further comprising tabulating the input histogram from the pixels of one or more previous input video frames in the video sequence.

11. (Original) The method of claim 10, wherein tabulating the input histogram comprises maintaining each bin of the input histogram by exponentially time-filtering a corresponding bin as calculated for sequential frame histograms, each frame histogram representing one frame in the video sequence.

12. (Original) The method of claim 7, wherein calculating the adaptive contrast-enhancing function is performed once for every input video frame.

13. (Original) The method of claim 7, wherein the adaptive contrast-enhancing function has a pixel level output range different than the range of input pixel levels below the pixel level threshold.

14. (Currently Amended) The method of claim 1, wherein remapping for pixels both below and above the first pixel level threshold comprises using a pixel's level value as an index to read a value from a common lookup table that combines the adaptive contrast-enhancing function and the scene-stable remapping function.

15. (Original) The method of claim 1, further comprising detecting substantial changes in scene histogram content from one frame of the video sequence to a following frame.

16. (Original) The method of claim 15, further comprising, when a substantial change in scene histogram content is detected, allowing the adaptive contrast-enhancing function to change more rapidly than it is otherwise allowed to change.

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17. (Original) The method of claim 15, further comprising, when a substantial change in scene content is detected, allowing the scene-stable remapping function to change substantially.

18. (Original) The method of claim 1, wherein the scene-stable mapping function remaps a pixel to an output level that is a linear function of that pixel's input level.

19. (Currently Amended) An apparatus comprising a computer-readable medium containing computer instructions that, when executed, cause a processor or multiple communicating processors to perform a method for video contrast enhancement comprising:

setting a first pixel level threshold for an input video frame in a video sequence, the input video frame including a plurality of pixels having corresponding pixel values within a pixel value range, where the first pixel level threshold is set to one of the pixel values within the pixel value range;

when a given input-video-frame pixel's level value is below the pixel level threshold, remapping that pixel according to an adaptive contrast-enhancing function; and

when the given input-video-frame pixel's level value is above the pixel level threshold, remapping that pixel according to a scene-stable mapping function.

20. (Original) The apparatus of claim 19, the method further comprising calculating the adaptive contrast-enhancing function to remap an input histogram for pixels below the pixel level threshold to a new histogram specification.

21. (Original) A video contrast enhancer comprising:

a contrast-enhancing function generator capable of accepting a target histogram specification and a set of histogram bins derived from one or more frames of a video sequence, the bins representing a histogram at least for pixel levels below a selected pixel level threshold, the function generator capable of generating a remapping function for input pixel levels below the threshold based on the target histogram specification and the set of histogram bins; and

a scene-stable mapper to control the remapping function for input pixel levels above the threshold.

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22. (Original) The video contrast enhancer of claim 21, further comprising a pixel remapper capable of accepting a pixel level from an input video frame and outputting a corresponding remapped pixel level according to the remapping function.

23. (Original) The video contrast enhancer of claim 22, wherein the pixel remapper comprises a lookup table indexed by input pixel level, the lookup table supplying the remapped pixel level according to the remapping function.

24. (Original) The video contrast enhancer of claim 21, further comprising a histogram calculator capable of constructing a frame histogram for the input video frame.

25. (Original) The video contrast enhancer of claim 24, wherein the bins of the frame histogram are supplied to the contrast-enhancing function generator as the set of histogram bins.

26. (Original) The video contrast enhancer of claim 24, further comprising a temporal histogram filter to supply the set of histogram bins for use by the contrast-enhancing function generator, each bin comprising an exponentially time-filtered combination of sequential frame histograms from the histogram calculator.

27. (Original) The video contrast enhancer of claim 26, further comprising a scene change detector capable of detecting scene changes based on a comparison of successive frame histograms from the histogram calculator and supplying a scene change signal when a scene change is detected in the video sequence, the temporal histogram filter applying a different time constant when the scene change signal is asserted.

28. (Original) The video contrast enhancer of claim 21, further comprising a threshold calculator to calculate the set threshold to correspond to a selected percentage of the pixels represented in the histogram bins.

29. (Original) The video contrast enhancer of claim 21, wherein the scene-stable mapper controls the remapping function to at least approximate a linear function of input pixel level.

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30. (Original) The video contrast enhancer of claim 21, further comprising:
a histogram calculator capable of constructing a frame histogram for an input video frame;
a frame buffer capable of buffering an input video frame until a remapping function can be calculated for that frame; and
a pixel remapper capable of accepting a pixel level from the buffered input video frame and outputting a corresponding remapped pixel level according to the remapping function.

31. (Original) The video contrast enhancer of claim 21, wherein the contrast-enhancing function generator is also capable of generating a remapping function for input pixel levels above a second selected pixel level threshold higher than the first threshold, based on the target histogram specification and the set of histogram bins, and wherein the scene-stable mapper controls the remapping function for input pixel levels between the two thresholds.

32. – 35. (Cancelled)

36. (New) A method of video contrast enhancement comprising:
setting a pixel level threshold for an input video frame in a video sequence, the input video frame including a plurality of pixels having corresponding pixel values within a pixel value range, where the pixel level threshold is set independently of the number of occurrences of the pixel values within the input video frame; and
when a given input-video-frame pixel's value is below the pixel level threshold, remapping that pixel according to an adaptive contrast-enhancing function; and
when the given input-video-frame pixel's value is above the pixel level threshold, remapping that pixel according to a scene-stable mapping function.

37. (New) The method of claim 36 includes contrast-enhancing only pixels from the input video frame with lower pixel values.

38. (New) The method of claim 36 includes contrast-enhancing only pixels from the input video frame with lower and higher pixel values, and not contrast-enhancing

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pixels with middle pixel values.

39. (New) The method of claim 36 includes contrast-enhancing pixels from the input video frame with lower pixel values, and not contrast-enhancing pixels with middle pixel values.

40. (New) The method of claim 39 includes contrast-enhancing pixels with higher pixel values.